

Carboniferous normal faulting in the Caledonides of the West of Ireland: a neglected phenomenon?

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Outcrop and regional scale studies of faults from the Connemara area and from Clew Bay, in particular, suggest the existence of large-scale (up to 800m throw) Carboniferous normal faults. Some of these structures juxtapose Carboniferous against Lower Palaeozoic rocks and were previously considered to be Tertiary normal faults, whilst others juxtapose Lower Palaeozoic rocks at outcrop level, and were previously interpreted as high angle Silurian thrusts. The reinterpretation of these structures as Carboniferous normal faults, in which outcrop level juxtapositions derive principally from Carboniferous displacements, does not rule out either an origin from reactivation of earlier Caledonian structures or some minor component of Tertiary reactivation.

Previous studies of post-Caledonian faults in Connemara argue for a significant phase of Tertiary normal faulting to explain the present day terrain and the offset geometry of the base Carboniferous unconformity. The latter indicates a series of NE-E striking faults with vertical displacements ranging up to 850m. Here we review existing constraints and present new data on the geometry and timing of these faults. We suggest that the most parsimonious interpretation of the available data is that these faults are of Dinantian age, although some minor Tertiary reactivation cannot be ruled out. The main lines of evidence are:

- (i) The geometry and scale of these normal faults is comparable with those of the Dinantian faults of Ireland (i.e. those with associated syn-depositional effects and Zn-Pb mineralisation), in particular, those along strike to the north-east.
- (ii) Tertiary faults of similar scale or orientation are not seen in seismic datasets from offshore West of Ireland and cannot be demonstrated from outcrop constraints further to the northeast. For example, the vertical displacements on faults offsetting the Tertiary/Cretaceous sequence of the Antrim Plateau are significantly lower (< 200m) than the displacements of Carboniferous rocks (ca 1000m).
- (iii) There is no compelling evidence in the west of Ireland for significant fault-related displacement of other Tertiary structures (e.g. dykes).
- (iv) Recent differential erosion of sequences across 'dead' faults provides 'resequent fault scarps' in other faulted areas (e.g. in Western USA). We suggest that differential erosion of Carboniferous sediments and of underlying basement could generate the present-day terrain, with no requirement for Tertiary faulting.

Outcrop studies in the Clew Bay and the Louisburgh area, highlight the existence of E-W faults, previously considered to be Silurian thrusts (e.g. the Emlagh thrust in the Louisburgh area and the Kill fault on Clare Island), that parallel the main Clew Bay-Leck Fault which has a 850m downthrow to the north and contains Carboniferous units in its hangingwall. There are a variety of lines of evidence suggesting that these thrusts, at the very least, accommodated normal fault movements associated with the Clew Bay-Leck Fault.

- (i) The faults post-date demonstrable Caledonian folding and cleavage development.
- (ii) Though the faults are generally E-W oriented, they link into, and appear to splay south-westwards from, the Clew Bay-Leck fault.
- (iii) Each fault shows a normal sense of stratigraphic offset, downthrowing and dipping to the north, in sympathy with the Clew Bay-Leck fault.
- (iv) Minor faults associated with the Emlagh and Cooneen 'thrusts', in particular, are numerous and exclusively normal.
- (v) Main fault dips are moderate-steeply dipping (40-60⁰) to the north, with the exception of the Cooneen 'thrust' that has a shallow northward dip (10-20⁰).

Our interpretation of the existence of Carboniferous normal faults in the West of Ireland, and in the Clew Bay area in particular, has a number of significant implications. Uplift and erosion has exposed the deeper levels of Carboniferous faults, the structural definition of which has eluded all previous studies in the poorly exposed Carboniferous successions of the Central Plains of Ireland. Analysis of these faults may provide useful constraints on the fluid flow systems underlying and sourcing fault-controlled Carboniferous Zn-Pb mineral deposits. The presence of post-Caledonian structures entirely contained within Caledonian rocks at outcrop level arises from the localisation of Carboniferous normal faults within and adjacent to the Caledonian Fair Head-Clew Bay line and reinforces the importance of Caledonian structure on later structural development.